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MILESTONE 5
REGIONAL COMMUTER RAIL/ HIGH CAPACITY TRANSIT PLAN ADDENDUM-MODELING RESULTS

HIGH-CAPACITY TRANSIT PLAN

Maricopa Association of Governments

5.4 High Capacity Transit MAG Model Results Comparison

To assist in the evaluation of the Recommended High Capacity Transit Network, the Maricopa Association of Governments (MAG) utilized their four-step transportation model to forecast ridership and system utilization for all proposed corridors contained in the network. This model run allows for the opportunity to observe how each of the proposed corridors operates as part of a larger network of corridors, creating linkages between corridors and assess the influences of complementary and completing corridors. In the previous milestones, all corridor ridership projections were the result of sketch planning forecasts, which forecasted ridership in each corridor independently. This limitation of the sketch planning model prevented analysis of the entire recommended network operating as a cohesive unit.

The MAG model run results provided range of data regarding several performance aspects of the recommended network. A summary of the data provided and its use are presented in Table 5.4-1 below.

Table 5.4-1 **MAG Model Results and Output**

Output	Use in Analysis
Base Transit Network Ridership	To provide an understanding of the base transit network and mode share.
High Capacity Transit/Base Transit Network Ridership	Identifies the difference in transit ridership for both high capacity and local transit services with the implementation of the high capacity transit network.
Transit Trip Win/Loss	Identifies the change in transit ridership resulting for the new transit services by traffic analysis zone.
High Capacity Transit Segment Volumes	Identifies specific ridership levels in each corridor by segment. Assists in identifying strong segments of lines and travel patterns.
High Capacity Transit Station Boardings	Identify specific boarding figures by station. Assists in determining major load points and transfer points.
Volume/Capacity Ratios	Check on traffic congestion levels assumed on arterial streets and freeways in the model.

Four-stage modeling and sketch planning modeling methods each have positive attributes and limitations in terms of assessing high capacity transit services. Because of these varying attributes and limitations, it was agreed between MAG and project consultant that both modeling methods should employed during the development of the High Capacity Transit Plan in order to perform appropriate analysis on the recommended corridors. Previous Milestone Reports included ridership forecasts for high capacity transit ridership using a sketch planning direct demand approach. This method determines transit trips based on trip rates for population and employment, using catchment areas within distance bands of transit stops. Attempting to develop accurate mode splits using four-stage modelling can be difficult for modes with low shares, and the direct demand (sketch planning) approach avoids this by combining the trip generation and mode split steps. It is particularly suitable when attempting to forecast for a new mode as in this case, when calibration of a conventional mode split model is not possible locally.

However, direct demand models only forecast for transit lines in isolation, and so are insensitive to network effects that can influence transit demand, such as road congestion and the interaction between transit corridors. Therefore parallel forecasts were developed using the four-stage MAG regional model. While not intended to supersede the sketch-planning projections, this additional analysis may provide additional detail and perhaps indicate whether the network effects are positive or negative for individual corridors.

5.4.1 Comparison of the Results

Overall, the MAG model forecasts around a third more riders than the sketch planning methodology. However, two corridors - Bell Road and the BNSF commuter rail line - can explain over 80 percent of this discrepancy. There are technical reasons for the high MAG model ridership along these corridors, and these are explained below. If these two corridors are removed, overall ridership is only 7 percent above the sketch planning results. Table 5.4-2 below compares each corridor in turn.

Table 5.4-2 **Comparison of MAG Model and Sketch Planning Results by Line**

Corridor	MAG Model Forecast	Sketch Plan Forecast	Difference
59th Ave	14,290	12,829	11%
Bell Rd	57,680	19,750	192%
Chandler Boulevard	5,201	12,226	-57%
UP Chandler	5,666	12,534	-55%
I-10 West	4,871	13,765	-65%
Power Rd	2,484	8,653	-71%
Scottsdale Rd	27,727	20,672	34%
SR-51	10,204	12,334	-17%
BNSF	28,227	8,073	250%
UP SE	9,594	4,552	111%
UP Yuma	16,163	6,017	169%
Glendale/Camelback	21,848	15,352	42%
Central Ave	2,965	5,749	-48%
Mesa Rd/Metro Center	87,610	71,039	23%
TOTAL	**294,530**	**223,545**	**32%**

MAG model projections for the other two commuter rail lines are also higher than sketch planning projections, particularly for UP Yuma. On the other hand, projections for some of the lines in the south east of the MAG region are lower.

It should be noted that all light rail transit (LRT)/bus rapid transit (BRT) corridors were run as LRT corridors in order to analyze the corridors on an equal footing terms of operations and system configuration. Specific technologies for each corridor would be determined in subsequent Major Investment Studies (MIS) performed in each corridor. Observations on recommended transit technologies will be included in the Final Report.

West Valley Growth

The largest discrepancies between the MAG model and the sketch-planning model occur for the BNSF commuter rail corridor and the Bell Road BRT/LRT line. It is believed that the very high ridership predicted by the MAG model for these corridors is overstated, due to unrealistic congestion on the roads in the area. Congestion is a network effect not included in the sketch-planning model.

A high rate of both population and employment growth has been projected for the West Valley. For instance, between 2000 and 2040 the population of Surprise is forecast to increase over 17 times above its current level. This represents an increase from 1.2 percent to almost 9 percent of the MAG region's population. Employment growth for the city is even greater, projected to increase almost 22-fold increasing the proportion of the region's jobs from 0.6 percent to 5.1 percent by 2040. This growth in population and employment leads to very large increases in trips made to and from the West Valley.

However, neither the base transit network, nor the base highway network, keeps pace with this growth in trips. The result is severe congestion on the only major roads in the area, with a consequent drop in level of service. For instance, speeds in places on Grand Ave and Bell Road in the AM peak drop as low as 1mph and 2mph respectively. These low speeds lead to extended auto journey times and hence make transit a very attractive alternative, overstating mode shares. In reality, should congestion reach such high levels the overall number of trips would actually be suppressed, but with the fixed matrix trips continue to be made - leading to very high transit ridership.

Exhibit 5.4-1 **Projected Year 2040 Transit Trips Including High Capacity Transit Network**

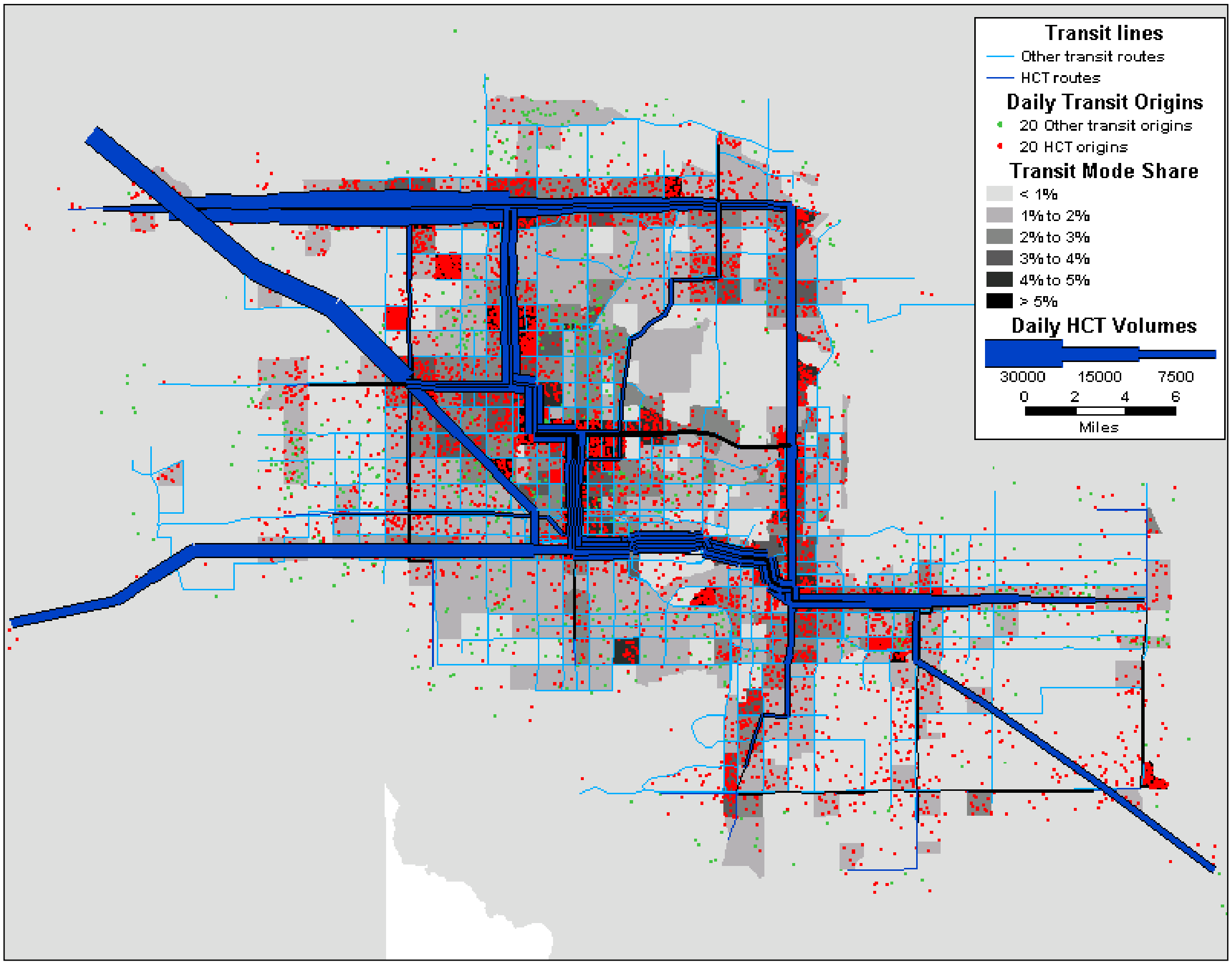

Exhibit 5.4-1 illustrates the high capacity transit ridership, and the origin of transit trips. While ridership on the BNSF and Bell Road is highest in the northwest, there are few origins to the northwest of these stations. It appears that congestion is so severe that trips are actually made in the outbound direction in the AM (i.e. against the peak) or around Loop 303 to avoid congestion, causing the vast majority of boardings to occur at these stations.

Rapid growth in population and employment also occur in the southwest (i.e. UP Yuma corridor), leading to congestion in this area and hence perhaps a slight overstatement of ridership. However, congestion in this corridor does not appear to be as severe as that in the northwest, and this may be due to the presence of the I-10 freeway. This facility has more capacity than the lower standard roads in the northwest such as Bell Road and Grand Avenue.

While the unrealistic levels of congestion suggest we cannot use the MAG model projections for the Bell Road LRT/BRT and BNSF commuter rail directly, they do confirm that these are nonetheless strong corridors with good growth potential. They indicate that the sketch planning forecasts are on the conservative side and future congestion in this area may lead to some upside.

Complementary Corridors

A second network effect not included in the sketch planning approach is the increased ridership that the connectivity of a network can provide. If interchanges are smooth, with short wait times, the effective corridor serves not just the immediate catchment area, but rather all areas of the MAG Region in the catchment area of any high capacity transit corridor. The MAG model includes this effect, and the impact is most obvious for the longer corridors, which may provide the most interchange opportunities. Time benefits are also not explicitly included in the sketch-planning model. As these increase with corridor length, this may be another reason why the longer corridors tend to have higher ridership projections relative to the sketch planning approach.

Projections from the MAG model for Scottsdale Road projections are over a third higher, showing the effect of good connections with Bell Road, Camelback Road, and Central Phoenix/East Valley LRT corridors. Glendale and Camelback are combined into one service in the MAG model projections. The creation of a through-running corridor across the central portion of the MAG region, as well as other connectivity, helps to increase the projections in these corridors by 42 percent relative to those from the sketch planning approach. It should be noted that some of these extra riders are probably due to overstated transit trips from the northwest.

Perhaps the strongest example of the network connectivity benefits is the Metrocenter/I-17-CP/EV-Main Street corridor. This extended route is the spine of the high capacity transit network and, therefore, it has the most opportunities for interchange with other corridors. While a small part of the 28 percent increase in ridership from the sketch planning projections may be due to congestion from the northwest valley, these results mostly illustrates the strategic benefit of a transit network rather than a single corridor.

The ability to interchange between corridors is not represented in sketch plan model, so it is intuitive that projections for these corridors are higher. Overall, where connectivity rather than competition is the main network effect, ridership is around 25 percent higher than the sketch planning results. Although some of this increase may be due to northwest congestion concerns, the MAG model confirms the strength of these corridors, the effects of connectivity, and suggests an increased likelihood of upside compared to downside.

Competing Corridors

Where two corridors serve similar origins and destinations, they may compete for transit riders. This third network effect is not included in the sketch-planning model. In this case, MAG model can indicate where competition may occur, and the impact this competition may have upon ridership projections.

The most obvious example of the competition effect is the interaction between the UP Yuma commuter rail corridor and the I-10 West LRT corridor. MAG model projections for UP Yuma are 169 percent higher than the sketch planning projections, while I-10 West projections are 65 percent lower. However, by combining the two corridors MAG projections are only 6 percent higher. These results suggest that trips in the I-10 corridor are instead using the UP Yuma commuter line, for reasons discussed below.

There may be a similar competition effect in the East Valley, where MAG projected ridership for many of the LRT/BRT corridors is substantially lower than projected by the sketch planning approach, while ridership for UPSE commuter rail and the Main Street LRT corridor are higher. Combining all the corridors of the East Valley (UPSE, UP Chandler, Power Road, Chandler Boulevard, and Mesa-I-17/Metrocenter LRT) gives MAG model ridership figures only 1% higher than from the sketch planning approach. While the Main Street corridor also includes trips on the Metrocenter/I-17 and CP/EV sections, it could be argued passengers are accessing this section from the Main Street section directly in the MAG model, rather than by interchanging from other East Valley corridors.

It would therefore appear that it is the distribution of trips between competing corridors rather than overall totals that are most different. One reason for this may be due to the access methods represented. The sketch planning approach assumes that there is strong provision of feeder services to the high capacity transit network. However, the MAG model network does not include these feeder networks, merely superimposing the HCT network on the existing transit network. Instead, much of the HCT network is accessed by car – almost 80 percent of trips are made this way, more than double the proportion observed in other LRT systems in Southwest United States[1].

Park-and-ride tends to favor commuter rail, which has higher line-haul speeds and fewer stops, so this may lead to the MAG model projecting higher mode shares for commuter rail where it competes with LRT/BRT. Congestion may be encouraging park and ride trips to use the outer UP Yuma line stations rather than the I-10 West stations. This would probably have been more likely based on the transit trip origins. Road congestion is less of a problem in the East Valley, although there does appear to be evidence of some trips being made outbound to Queen Creek. For most areas, park-and-ride and kiss-and-ride trips are not forced to the nearest station, but to the corridor with the shortest line-haul times and with the fewest

[1] Source: Parsons Brinkerhoff Quade & Douglas, Inc 1999, Phoenix Model Development Project

interchanges. With feeder services, it may be more convenient for many of these trips to access a nearer LRT/BRT corridor and make more interchanges.

The representation of commuter rail in the MAG model may also lead to an overstatement of its mode share relative to LRT. As commuter rail is a new mode, the mode choice sub-model cannot be calibrated explicitly, and instead it is represented as a high-speed LRT with limited stops. In reality, however, commuter rail station access is generally less convenient than LRT, which would tend to depress demand. The LRT corridor emphasis on 'turn up and go' also leads to them attracting higher demand than commuter rail corridors where journey times are similar.

Table 5.4-3 provides a context for the MAG model commuter rail forecasts in a comparison with existing systems. The boardings per mile comparison suggests that the MAG model projections are out of line with other systems in the Southwest United States systems, and could only be attained with urban development at least as dense as Toronto, Canada. On the other hand, the peer comparison confirms the sketch planning forecasts are in line, if a little higher due to the distant timescale the forecasts represent.

Table 5.4-3 **Comparison of Commuter Rail Forecasts with Existing Systems**

Line	Distance (miles)	Boardings	Boardings per Mile
Observed Peer Transit Systems			
Los Angeles Metrolink IE-OC	59	3,003	51
San Diego Coaster	43	5,000	116
Dallas Trinity Railway Express	37	5,900	159
San Jose Altamont Commuter Express	82	3,300	40
Toronto Go Transit Lakeshore East	42	40,715	969
Chicago NICTD Southshore Line	90	12,800	142
MAG Model Forecasts			
BNSF	28	28,227	1,018
UP Yuma	33	16,163	497
UP Southeast	36	9,594	265
Sketch Plan Forecasts			
BNSF	28	8073	291
UP Yuma	33	6017	185
UP Southeast	36	4552	126

While this may suggest that MAG model projections for the commuter rail lines may be overstated at the expense of understated BRT/LRT line projections, it does perhaps indicate the most likely direction actual ridership may diverge from the forecasts. There may be potential for some downside with the BRT/LRT corridors in the East valley - particularly for Power Road - while UP SE and the Main Street LRT corridor have potential for upside.

Other Corridors

Projections for 59th Avenue and SR-51 corridors are similar between the MAG model and sketch plan approach, and show overall compatibility between the two sets of results. MAG model projections for Central Avenue are somewhat lower however, and it is believed that this illustrates another aspect of competition between transit lines.

The MAG model includes an existing bus service operating along Central Avenue with a headway of 12 minutes, similar to the high capacity transit headway of 10 minutes. As this also continues north of downtown Phoenix, it is attractive to transit riders despite its lower speed. Assuming the existing service would be truncated following the introduction of the high capacity transit service, passengers boarding the existing service can be included in the high capacity transit ridership where it operates the same route. This increases the MAG model projections for the Central Avenue South LRT to 5,140, only 11 percent below the sketch planning forecasts.

5.4.2 Using the Results

Table 5.4-4 below combines the corridors into the groups defined above.

Table 5.4-4 **Comparison of Modeling Results by Corridor Group**

Corridor Group	MAG Model Forecast	Sketch Plan Forecast	Difference
BNSF/Bell Road	85,907	27,823	209%
Increased Connectivity	137,185	107,063	28%
UPYuma/I-10 West	21,034	19,783	6%
East Valley[2]	110,555	109,004	1%
Other[3]	29,634	30,912	-4%
TOTAL (Adjusted)[4]	210,798	195,722	8%

This grouping shows that while comparisons on a line-by line basis initially suggest large differences between the modelling approaches, overall differences are much smaller. The largest difference is due to the congestion problems of the northwest, but that aside the largest impact appears to be the network effects of connectivity, slightly increasing overall ridership.

[2]Includes Metro Center and CP/EV
[3]Includes Central Avenue existing bus service.
[4]Includes Central Avenue existing bus service but does not include BNSF or Bell Road. Forecasts do not add up to total as Metro Center-CP/EV-Main Street corridor is included in both “East Valley” and “Increased connectivity” categories

Calculated from such small mode shares, the MAG model projections should be treated with caution at a detailed level. For the NW sector, even the order of magnitude can only be determined from the sketch planning results. However, they can indicate whether a corridor has more potential for upside or downside, and also provide some useful additions to the network-insensitive sketch planning approach.

Comparisons with the sketch planning projections can allow the adjustment of implementation priorities. Power Road, for instance, may be lowered in the priority list, while the commuter rail lines along the BNSF and UP Yuma may be moved up. The technology assumed for each corridor can be fine-tuned, with Bell Road, for instance, suggesting LRT level of service - even after allowing for the road congestion effects. Power Road is unlikely to warrant a technology more expensive than BRT.

Finally, as a regional model, the MAG model can provide context for the corridor projections. It shows the continuing dominance of the car in the MAG region, with overall transit mode share at only 1.2 percent even with the development of a network of high capacity transit corridors. However, if we consider that more than a third of high capacity transit ridership is from zones with transit mode share above 5 percent, even discounting the problems of the northwest sector the MAG model suggests that where high capacity transit service is provided a reasonable mode share for transit can be achieved.